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ENVIRONMENT AND ENVIRONMENTAL GEOLOGY

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INTRODUCTION

Present interest of the public in ecology and environment has been well-publicized. Until recently, the words *ecology* and *environment* were seldom heard, but now there is a deluge of material concerning subjects ranging from diminishing natural resources and burgeoning population to the desirability of preserving pleasing landscapes.

Public interest in environmental matters seems to be more substantial than "just another fad". For example, an increasing population, with increasing demands for most everyday living items, is discovering the capabilities of the earth are finite and limited. Also, these limitations frequently affect the daily lives of individuals and they are not just impersonal and theoretical.

As a result, the public has shown a receptiveness for environmental information and a growing awareness of its importance. Rachel Carson, in her book, "Silent Spring" (1962), alerted the public to potential dangers resulting from unrestricted use of pesticides, and Paul Ehrlich, in "The Population Bomb" (1970), pointed out some possible consequences of uncontrolled population growth. Both books were best-sellers. Public awareness of environmental matters reached a climax three years ago when the United States Congress passed Public Law 91-190, the National Environmental Policy Act of 1969, which requires, among other things, a detailed statement of probable impact of all major Federal projects upon the environment. The ultimate goal of such legislation is to make consideration of environmental factors an integral part of overall project planning, and not just an afterthought. In this way, it is hoped, alternative courses of action will be considered and the true, total costs for any proposed project will be determined.

The first step in the growing public awareness of environmental matters — the showing of need, or "cry of alarm" — is drawing to a close, and a second step — investigation — is beginning. The investigation phase requires a complete and accurate inventory of available resources, which includes gathering and compiling data, and developing analytical procedures with which to evaluate the data. Such an inventory forms the basis for designing programs to achieve desired goals and making decisions necessary to implement these programs.

During the investigation phase, when headlines pass on to other topics and publicity tends to die away, some persons are tempted to conclude public interest has also died away, when, in reality, this *quieting down* simply marks the transition from initial alarm to detailed, systematic, and quantitative investigation. For, in instance after instance, initial interest in some environmental area not only showed what was known, but also what was *not* known. Growing environmental awareness spotlighted data gaps in many fields, and geology was no exception. Without fully realizing it, geologists had become more and more accustomed to talking solely with other geologists.

EARLY GEOLOGY

Geology began in a number of places, largely as a practical sort of thing, and, from this practical point of view it has always been *environmental.*

William Smith, an English surveyor and engineer of the 1790's, found a persistent sequence of rock strata along the route of the Somerset Coal Canal in England, construction of which Smith was supervising (Adams, 1954, p. 269). The persistence of the strata made it possible to predict, prior to excavation, what sort of rocks would be found along a section of the canal. This was useful information.

Early geologists, including Smith, studied fossils, the petrified remains of organisms which are found in rocks. They soon learned identical fossils were one way to identify identical rock strata at widely separated localities, although the other characteristics of the rocks were greatly different. The different characteristics of the rocks resulted from different events that had occurred in the past, but the identical fossils showed these events had taken place at the same time.

Stratigraphy, the part of geology concerned with the study of rock strata, was developed on this sort of "time basis". That is, rock strata everywhere were — and are — considered to be subdivided by surfaces called *time planes*. Ideally, a time plane is the same age everywhere and the rocks contained between two of them were all formed during the same interval of time. In actual practice, the planes are highly irregular surfaces that are both real and invisible. Various features in rocks are interpreted as indicating a "time plane", but the "plane" itself is not seen.

As these and other more complicated concepts evolved, a specialized vocabulary evolved and standard procedures for doing certain things were defined so that geologists could more readily compare data. Unfortunately, as this specialization proceeded, direct communication of geologic information to non-geologists decreased greatly.

EARLY ECOLOGY

As numbers of men increased and their cultures grew more complicated and complex, they found with increasing frequency that *the environment* came to them — they did not have to seek it out. From being feared, then worshipped, and finally ignored, Nature came to be recognized as something to be accounted for in the plans of men. As long ago as 1273, men found if they wanted to live in cities as large as the London of that day, it was deemed necessary to restrict the large-scale burning of coal to prevent undesirable air pollution (Cadle, 1970, p. 135). Even by that day, man's ability to dirty the air in some areas had outstripped the capability of naturally-occurring processes acting to cleanse it.

Today's cultures are even more complicated and complexly interlocked. Barry Commoner, a biologist has stated this in his First Law of Ecology: "Everything is connected to everything else" (Commoner, 1971, p. 33). Peter Flawn, a geologist, has stated there is simply less margin for error in more and more of man's activities without producing disastrous, unacceptable results (Flawn, 1970). In addition, diminishing natural resources and increasing population make it necessary to use our resources as efficiently as possible. It is necessary to get the most use from the least resources. That is, utilization of resources must be optimized.

DEVELOPMENT OF ENVIRONMENTAL GEOLOGY

In the early 1960's, as cities grew larger and covered more ground and the word *megalopolis* was first heard, some geologists found application for their skills in large urban areas and thus *urban geology* was born. Although urban geologic studies proceeded, most of them seemed to attract little attention.

During this same period, developments in other fields, such as biology, noted earlier, aroused public interest in ecology and environment. In 1965, the Illinois Geological Survey began publication of a new series of "Environmental Geology Notes" and *environmental geology* it has been ever since. This series of publications has the stated purpose of informing ". . . engineers, professional planners, municipal, county, and state officials, and other interested individuals about current work . . . in their fields, and to provide . . . specific data and descriptive materials that otherwise would be available only . . ." to other geologists (Hackett and Hughes, 1965, Forward). In other words, geologists rediscovered the fact that they had something worthwhile to say to the general public, and particularly to decision-makers who are not geologists. They now have to re-learn more effective communication with the general public.

An early example of effective communication of geologic information is provided in a series of publications from Baylor University (Flawn and Burket, 1965). In these publications, accurate, but uncluttered, geologic maps are presented and form the basis for deriving various other kinds of information. These accompanying "derivative maps" are designed so that nearly any layman can understand the information they contain and put it to immediate, personal use. The complete set of maps forms an inventory of the natural, physical characteristics of the Waco, Texas area in easy-to-understand terms such as "high", "low", "strong", "weak", and "moderate". At the same time, care has been taken not to oversimplify the maps and compromise their geologic validity. For those who need the information, precise definitions of all general terms are included.

From 1965 to the present, environmental geologic publications have been increasing in number and sophistication. Some new concepts have been formulated and some old ones re-applied to environmental geologic investigations.

Some geologists object to the term *environmental geology*. They feel it represents an attempt to "cash in" on a current vogue and reflects discredit on the geological profession. True, environment is a much-used word these days. It doubtless has a variety of imprecise definitions that reflect the special interests of those persons doing the defining, special interests requiring discrimination and even polite skepticism on the part of the listener. The word environment does have the outstanding advantage, however, that when it is used, nearly everyone now has *some* idea of what is being discussed. This is an important start toward effective communication.

In some early environmental investigations, geologists accumulated data, made proper geologic interpretations, and then made value judgments or decisions, far outside their field of competance. This is generally not justified unless the geologist has additional training in other disciplines. For example, an environmental geologist is completely justified in pointing out a valuable, commercial-grade sand deposit in the path of an expanding urban area. But the decision whether or not to extract the deposit, build the city over it, or expand the city around it can only be made by the city government. Furthermore, whatever the decision, implementation of it will be the responsibility of other agencies such as zoning boards. It is the geologist's responsibility to effectively communicate a complete and detailed geologic inventory to these persons, in their terms, so their decisions can be as knowledgeable as possible. A few of the questions the geologist should be prepared to answer might be: How big is the deposit? What is the present (and projected future) demand for it? How valuable is it? How long will it take to exploit? Will exploitation cause any undesirable effects, such as land subsidence or slumping? Will exploitation cause any effect on other resources, such as ground-water?

While being careful not to pre-empt the responsibilities of others, an environmental geologist should also be careful not to allow others to pre-empt his geologic responsibilities. There are many instances where only a geologist can contribute the critical information needed for a project. In one instance, investigation of a dam failure in California, revealed the dam had been built partly on an alluvial fan containing interbedded layers formed by mudflows. A mudflow is a thick, viscous mixture of sediment and water that flows downhill until loss of fluidity causes it to stop. The remaining water slowly evaporates, leaving behind a distinctive sedimentary deposit recognizable to a geologist. In the case of the dam, water accumulating behind the dam resaturated and remobilized the mudflows in the alluvial fan. The mudflows moved, the land subsided as much as three feet, and the dam failed (Roberts, 1963). Projects fail, are more expensive than anticipated, or run the risk of not meeting specifications when geologic information is not an integral part of the planning and decision-making processes.

The purpose of environmental geologic studies is not necessarily to stop or unduly restrict human activities affecting Nature, but rather to inventory the natural geologic phenomena occurring in an area so human activities can be consciously designed for maximum harmony with Nature. The goal is to insure recognition of all available alternatives so a deliberate and knowledgeable choice can be made among different courses of action and to avoid unanticipated consequences and unnecessary expense.

Important and significant environmental geologic work can be done at very modest cost. Much valuable information already exists but is not fully utilized because it is not detailed enough and is expressed in geologic terms not readily understood by specialists in other fields. Fortunately, environmental geology deals with tangible, physical data that can be readily measured compared to some more aesthetic factors of environmental concern which seem to be impossible to measure for analysis.

GEOLOGIC BASIS FOR ENVIRONMENTAL GEOLOGY

For many years geologists have studied sediments in areas such as coastal zones in order to learn how older sedimentary rocks were formed. For example, in coastal areas the sediments, the active processes affecting them, and the resulting sedimentary deposits can all be observed, measured, and recorded. The effects of various active processes operating in coastal zones are preserved and can be recognized in the sedimentary deposits that are formed.

Actually, different sediments can be classified into different groups that are called depositional systems, on the basis of the active processes that influenced them. Such a classification is frequently more practical for environmental geologic studies than a classification that is established on a time basis. From many observations and detailed studies in coastal areas around the world, geologists have identified many active processes of geologic significance, the types of deposits produced by these processes, and the physical characteristics of the resulting sedimentary bodies.

This knowledge can be used in either of two ways. If the active processes and types of sediments along a coastal zone are known, the nature and distribution of the resulting sedimentary deposits in the depositional system can be generally predicted, not only at the surface of the earth where direct observation is possible, but in the subsurface as well, where it is necessary to obtain information by laborious and expensive drilling procedures. Knowledge of geologic processes and products make it possible to selectively place any needed boreholes in key areas, rather than use a blind, more expensive, shotgun approach.

The second way knowledge of depositional systems can be used is in areas where loose sediments have been transformed into rock. Detailed examination of rock exposure makes it possible to infer the former existence of various active processes, and, from this, the three-dimensional geometry of the rock bodies formed by these processes. Again, knowledge of depositional systems makes it possible to locate and examine critical areas to obtain additional information at minimum expense and to effectively show on maps the physical properties of the rocks which are of most interest.

Geologic information, organized into various depositional systems and shown on a map, forms a naturally occurring, independent description of an area. Because it is an "independent variable", the detailed geology provides a natural basis for extrapolating other physical characteristics through the same area. Sediment composition, various soil properties, percent topographic slope, excavation difficulty, and suitability for various uses are only a few of the many possible variables dependent upon geology which can be shown on separate derivative maps.

Derivative maps are the major end product of environmental geologic investigations. They show the practical applications that can be made immediately, at the personal level, by individuals. A major advantage of environmental geologic mapping is that it can often be accomplished more inexpensively than direct mapping of the physical properties of interest.

REFERENCES

Adams, F. D., 1954, The birth and development of the geological sciences: New York, Dover Publications, 506 p.

Cadle, R. D., 1970, Is clean air possible in an industrialized society?, *in* Helfrich, H. W., Jr., ed., Agenda for survival: New Haven, Yale University Press, p. 135-148.

Carson, R. L., 1962, Silent spring: Boston, Houghton Mifflin, 368 p.

Commoner, Barry, 1971, The closing circle: New York, Knopf, 326 p.

Ehrlich, P. R., 1970, The population bomb: New York, Ballantine Books, 223 p.

Flawn, P. T., 1970, Environmental geology: What is the responsibility of the science?, *in* Young, Keith, conv., Environmental geology: Washington, Am. Geol. Institute.

Flawn, P. T., and Burket, J. M., 1965, Urban geology of greater Waco, Part I: Geology: Baylor Geological Studies, Bull. 8, 46 p. The first of a series of seven bulletins dealing with various aspects of the same general topic.

Hackett, J. E., and Hughes, G. M., 1965, Controlled drilling program in northeastern Illinois: Illinois State Geological Survey, Environmental Geology Note No. 1, 5 p.

Roberts, G. D., 1963, Need for more geological information on alluvial fans (abs.): Geol. Soc. America, Spec. Paper 73, p. 63.

NEW PUBLICATIONS

Report of Investigations 29. BOUGUER GRAVITY IN VIRGINIA, 36°30′ TO 38°52′30″ N, 79°00′ TO 80°00′ W, by Stanley S. Johnson; 38 p., 2 maps in color. Price $1.25 (plus 4 percent State sales tax).

An area of approximately 7320 square miles in Virginia, between 79° and 80° west longitudes, was surveyed by gravimetric methods. A total of 1916 stations, utilizing bench marks, checked spot, and bridge elevations, were occupied. The reduced field data were computer-contoured. The area surveyed included parts of the Piedmont, Blue Ridge, and Valley and Ridge physiographic provinces. The maps indicate relationships with regional structures in the southwestern Piedmont where contour trends occur over the Danville basin, the Blue Ridge anticlinorium, the Sauratown uplift, the James River synclinorium, and a large allochthonous zone. A prominent gravity low on the Virginia-West Virginia state line and a high between Lexington and Staunton are the most noticeable anomalies in the area.

Report of Investigations 30. GEOLOGY OF THE YORKTOWN, POQUOSON WEST, AND POQUOSON EAST QUADRANGLES, VIRGINIA, by Gerald H. Johnson; 57 p., 3 maps in color. Price: $3.75 (plus a 4 percent State sales tax).

The Yorktown, Poquoson West, and Poquoson East quadrangles are areas in the lower York-James Peninsula portion of the Atlantic Coastal Plain. The morphology is dominated by a series of plains and scarps that range in elevation from about 90 feet north of Grove to sea level along Chesapeake Bay and along the York and James rivers. The plains and scarps are complex depositional-erosional features, which were formed during the Pleistocene. Dissection of the plains is most advanced on the higher plains and less extensively on the lower plains.

The Yorktown Formation in the Yorktown and Grafton areas contains marl and sand which are utilized in the construction of highways. Economically extractable deposits of sand and gravel occur in Norfolk Formation in the Grafton and Denbigh areas.

Information Circular 17. VIRGINIA GRAVITY BASE NET, by Stanley S. Johnson and Robert E. Ziegler; 22 p. Price: $1.00 (plus 4 percent State sales tax).

The Virginia Gravity Base Net, consisting of 58 adjusted gravity stations, has been established throughout Virginia. The Net was established with two LaCoste and Romberg Model G geodetic gravity meters. The Net is tied to the U. S. National Gravity Net stations at Dullas International Airport and at the Raleigh-Durham Airport. The gravity values derived are relative to the National Gravity Datum at Washington A which has a value of 980118.00 milligals. The statistical results of the adjustment indicate a mean standard propagated station error of ±.020 milligal and an RMS error for a single observation of ±.016 milligal.

Information Circular 18. BIBLOGRAPHY OF PUBLISHED MEASURED SECTIONS WEST OF THE BLUE RIDGE IN VIRGINA, by Harry W. Webb, Jr. and W. Edward Nunan; 219 p. Price $2.25 (plus 4 percent State sales tax).

Measured stratigraphic sections provide detailed information on the thickness, lithology, paleontologic content, facies characteristics, and other aspects of rock units at specific localities. The information can be used to depict where mapped units can be seen and studied and to determine the extent and nature of geologic units. This publication is a biblographic aid for use in locating published literature references to January 1, 1972 of measured sections of Paleozoic age rocks that crop out in Virginia west of the Blue Ridge.

Information Circular 19. BIBLIOGRAPHY OF VIRGINIA GEOLOGY AND MINERAL RESOURCES — 1950-1959, by F. B. Hoffer; 103 p. Price $1.25 (plus 4 percent State sales tax).

The present bibliography is patterned after the Bibliography of North American Geology, which is published annually by the United States Geological Survey. It lists the literature on the geology and mineral resources released from 1950 through 1959, plus some omissions from earlier bibliographies. Theses from colleges and universities in the United States and open-file reports which include data pertaining to the Commonwealth of Virginia are listed.

DIRECTORY OF THE MINERAL INDUSTRY IN VIRGNIA — 1972, by D. C. Le Van; 46 p. Price: $0.25 (plus 4 percent State sales tax).

ADDITION TO STAFF

Mr. George H. Liggon joined the Division staff on March 1, 1972, and will assist in the transfer of published and unpublished geology to 7.5-minute topographic quadrangles and in the topographic-mapping program. He received a B. S. degree in geology from Campbell College in 1970 and has completed the required courses for an M. S. degree in geology from North Carolina State University.

Mr. Liggon worked as a geologist in the locating department for the North Carolina State Highway Commission for three summers while completing his degree requirements.

Mr. Christopher R. Halladay joined the Division staff on April 1, 1972 and is assisting with laboratory projects and geochemical studies. He served in the U. S. Army during portions of 1968 and 1969. Afterwards he returned to college and obtained a B. A. degree in 1970 and a M. S. degree in 1972 from Lehigh University. Mr. Halladay is married.

PRICE CHANGE OF TOPOGRAPHIC QUADRANGLE MAPS

Effective September 1, 1972, the price of 7.5-minute series maps will be increased from $0.50 to $0.75 per copy; 1:250,000-scale series maps will be increased from $0.75 to $1.00 per copy.

TOPOGRAPHIC MAPPING PROGRESS

By means of the cooperative Commonwealth of Virginia-U. S. Geological Survey 7.5-minute series topographic-mapping program, all 805 published quadrangles needed to depict the Commonwealth will be available by the end of 1972. As of June 30, 1972, 779 maps were published. Of these, 127 have been updated, on which recent cultural changes are indicated in magenta.

A new method of map inspection, whereby each 7.5-minute series map of the Commonwealth will be examined for revision need every 5 years from high altitude photography began this year. Of the five sectors into which the State has been divided, section I, flown early this spring, is indicated on the index map (located on back page). Remaining sectors will be flown in the spring of successive years. As a byproduct of this aerial inspection, quad-centered photographs at a scale of about 1:72,000 will be available. One 9 inch x 9 inch print, available at $1.75 each, now depicts more than the entire area of a 7.5-minute series quadrangle; with the former lower altitude mapping photography about 9 prints were needed to depict a quadrangle. These new photographs can be enlarged as much as four times without loss of clarity to the unaided eye; a 3 times enlargement will have a scale of about 1:24,000 and will cost $4.50 per print.

AEROMAGNETIC SURVEY

An aeromagnetic survey that covers approximately 7,890 square miles in central and western Virginia will be released on August 14, 1972 by the Division of Mineral Resources. The survey includes the following 15-minute quadrangles: Gerrardstown, Blacksburg, Speedwell, Max Meadows, Macks Mtn., Elliston, Radford, Pulaski, Bland, Peaks of Otter, Roanoke, Salem, Waiteville, Pearisburg, Narrows, Bluefield, Buena Vista, Natural Bridge, Eagle Rock, New Castle, Ronceverte, Lexington, Millboro, Clifton Forge, Callaghan, Charlottesville, University, Waynesboro, Staunton, Craigsville, Williamsville, Warm Springs, Madison, Elkton, Harrisonburg, Parnassus, McDowell, Monterey, Cass, Stony Man, Mt. Jackson, Broadway, Fort Seybert, Spruce Knob, Strasburg, Edinburg, Orkney Springs, Petersburg, Winchester, Wardensville, Middletown, and Capon Bridge.

The magnetic contours are compiled on the topographic quadrangle at a scale of 1:62,500. The survey was flown at an altitude of 500 feet above terrain with east-west flight lines spread at half-mile intervals over the Piedmont, Blue Ridge, and for almost three miles westward over the Valley and Ridge from the western foothills of the Blue Ridge. The Valley and Ridge was flown at three-mile flight-line intervals at 5,000 feet above sea level. The survey joins four previous aeromagnetic surveys that were flown and released in 1962, 1965, 1970, and 1971.

The contour maps, which will be on open file beginning August 14, 1972 in the Division library at Charlottesville, will be available for reference use. Ozalid copies, available for purchase at a cost of $5.00 plus $0.20 tax per sheet, may be ordered from the Virginia Division of Mineral Resources, Box 3667, Charlottesville, Va. 22903.

TOPOGRAPHIC MAPS

Maps published from April 1, 1972 to June 30, 1972

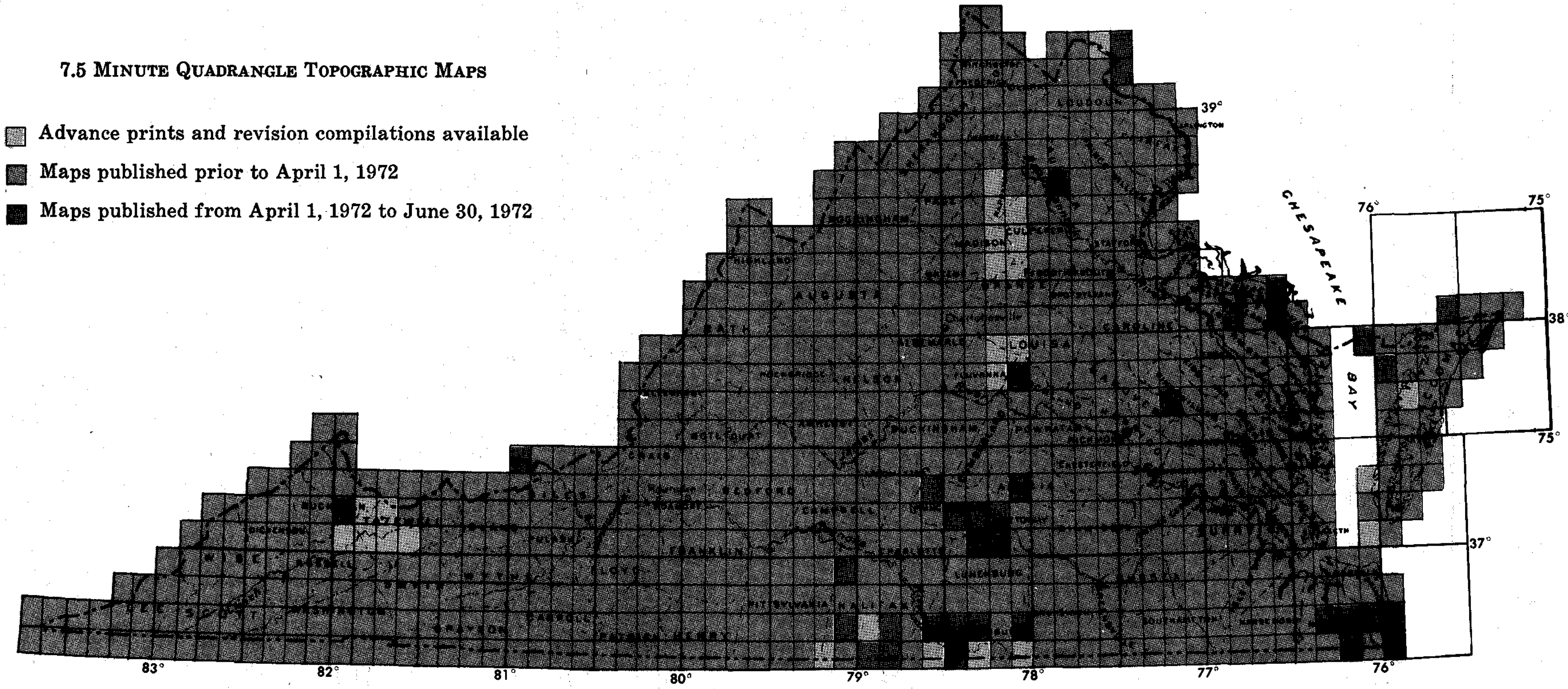
Baskerville	Hampton Sydney	Oak Level
Boydton	Keen Mountain	Pocomoke City
Buckeystown*	Kinsale	Poolesville
Caledonia	Knotts Island*	Piney Point
Clarksville North	La Crosse	Pleasant Ridge*
Cluster Springs	Lerona	Prospect
Crewe West	Manquin	Republican Grove
Deep Creek*	Meherrin	Rubermont
Ewell	Montross	Tangier Island
Fentress*	Moyock*	Tungsten
Green Bay	North Bay*	Virgilina
Jetersville	Omega	Warrenton*

*Updated map

As of June 30, 1972:	Number of Quadrangles	Percent of State
Number of quadrangles	805	100
Advance maps available	26	3
Modern maps published	779	97
Total number of available maps	805	100
Maps updated	127	16

7.5 Minute Quadrangle Topographic Maps

- Advance prints and revision compilations available
- Maps published prior to April 1, 1972
- Maps published from April 1, 1972 to June 30, 1972



ADVANCE PRINTS AND REVISION COMPILATIONS

Advance prints and copies of revision compilations are available at 50 cents each from the U. S. Geological Survey, Topographic Division, 1109 N. Highland St., Arlington VA 22210

PUBLISHED MAPS

State index is available free. Updated maps, on which recent cultural changes are indicated, are now available for certain areas of industrial, residential, or commercial growth. Published maps are available at 50 cents each from the Virginia Division of Mineral Resources, Box 3667, Charlottesville, VA 22903.

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HIGH-ALTITUDE PHOTOGRAPH MAP REVISION INSPECTION SECTORS

■ Sector I